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HUMAN FACTORS STUDY OF QMC CLOTHING AND EQUIPMENT  
DURING COLD WEATHER TESTS OF THE  
LITTLE JOHN WEAPON SYSTEM

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1. Introduction

The Ordnance Corps conducted cold weather tests of the LITTLE JOHN Weapon System Conditioning Kit, Rocket Handling Platform,\* and the rocket spin-up mechanism in the Climatic Hangar at Eglin Air Force Base, Florida, during June 1960. This report is based on observations made by a QMC psychologist during these tests, supplemented by comments made by LITTLE JOHN crew members. The basic purpose of the QMC study was to determine the effectiveness of the QMC cold weather clothing (under the test conditions), its compatibility with the operational requirements of the equipment, and the efficiency with which men equipped with the clothing can operate the equipment.

QMC participation in this test was at the request of the Test and Evaluation Laboratory, Ordnance Missile Laboratories, U.S. Army Rocket and Guided Missile Agency.

2. Method

The method of collecting data consisted primarily of direct observations of the equipment and of the men operating it. Also, the men were informally interviewed regarding the clothing and were encouraged to make comments concerning it and its adequacy at low temperatures. In addition, the observer manipulated some of the mechanical parts to determine their operability with arctic handgear. Additional information was obtained from interviews with Ordnance Corps technical personnel.

3. Conditions during the study

Observations were made in the Climatic Hangar at a temperature of -65°F. with approximately one half to two inches of snow covering the cement floor. Visibility was frequently limited by the presence of ice fog. Only the Sergeant in charge of the five-man crew had experienced extremely cold conditions previously.

4. Clothing issued

The members of the crew were issued the clothing items in Table I for use in the Hangar during the cold weather tests. They were briefly instructed in its proper utilization under the test conditions.

\* A 2 1/2-ton long-bed truck

TABLE 1: CLOTHING ITEMS ISSUED\*

<u>Description of Label</u>
Undershirt, Winter, M-1950
Drawers, Winter, M-1950
Shirt, Field, Wool, OG108
Trouser, Shell, Field, M-1951
Liner, Trousers, Field, M-1951
Trouser, Shell, Field, Arctic, M-1951
Liner, Trousers, Arctic, M-1951
Suspenders, Trousers, M-1950
Jacket, Shell, Field, M-1951
Liner, Jacket, Field, M-1951
Parka, Shell, M-1951
Liner, Parka, M-1951
Hood, Winter, M-1951 (with fur ruff)
Cap, Field, Pile, M-1951
Socks, Wool, Cushion Sole, O.D. (two pairs)
Boots, Combat, Rubber, Insulated, Dry Cold
Mittens, Arctic (with harness)
Gloves, Anti-contact

\* Items were issued in the available size which gave the best fit.

5. Comments concerning the clothing

In general, the men reported that the QMC clothing kept them sufficiently warm under the conditions of the test. They indicated that the dry cold boots kept them adequately warm and were satisfactory. Body clothing was considered too bulky and required too much time to don and doff. The arctic mittens restricted manual dexterity considerably, but kept the men's hands warm when they were worn. The mittens were removed and anti-contact gloves were used for tasks requiring a high degree of dexterity.\* However, cooling of the hands occurred rapidly when the latter gloves were used.

Inadequate closure between the cuff of the parka (or the field jacket) and the top of the anti-contact glove leaves a section of the wrist exposed. One man received a "burn" when his exposed wrist accidentally contacted a metal part on a piece of equipment.

The helmet and helmet liner were not worn during the test. Consequently the compatibility of these items with the rest of the equipment could not be determined.

Cloth hospital type face masks available at the Climatic Hangar were worn by the crew. These masks become wet and frosted on the outside after a short period of wear, but they helped to keep the face warm.

6. Observations on the equipment

Although the launcher, trailer, and rocket of the Prespin Automatic Dynamic Alignment (PADA) version of the LITTLE JOHN weapon were in the Hangar, the major objectives were primarily to test the rocket spin-up mechanism, the Conditioning Kit and the Rocket Handling Platform. The PADA version of the system was evaluated in the Hangar during November 1959 (2). Some modifications were made in the rocket spin-up mechanism and in the Conditioning Kit. Due to these modifications, and the fact that the Rocket Handling Platform had not been subjected to a winterization test previously, this cold weather test was conducted.

The Conditioning Kit consists of a frame type tent, a heater-generator and a lamp assembly.

a. Tent

When the tent was tested in the Hangar during May 1959, the material of the outer skin became very stiff at -65°F. and as a result would not go on the frame (1).\*\* A major modification to the outer skin was the

\* Anti-contact gloves were worn underneath the arctic mittens.

\*\*The outer skin was constructed out of nylon impregnated neoprene.

construction of larger roof sections with cross-webbing and take-ups for slack on each side of the roof. This approach was expected to simplify the problem of getting the outer skin on the frame. The liner suspension system was also modified and the ground cloth was increased in size.

Without a source of heat to warm the outer skin, it took the crew of six men a total of about 2 1/2 hours to erect the modified tent. When warmed by the heater-generator the tent was erected in approximately 45 minutes. The cold soaked tent required more time to erect mainly because of the creases in the outer skin and its excessive stiffness. (Fig. 1) This lack of pliability made it almost impossible to smooth out the creases, which in effect made the outer skin smaller, and even more difficult to work with. Despite the fact that the roof sections had been made larger, it was very difficult and time consuming to get the outer skin onto the frame, and then it did not go on properly.\* If feasible the outer skin should be constructed out of a material that retains its pliability at low temperatures.

When the heater was used in conjunction with the tent erection, the heater (intake and output) ducts were placed under the tent framing immediately after the three liner sections had been placed on the frame. The heat made the outer skin fairly pliable shortly after it had been placed over the liner. The three sections of the outer skin were then fastened together and to the frame in considerably less time than it had taken when the erection was performed without heat.

The rope used to lace together the packing cover for the tent framing was tied and untied with anti-contact gloves. The latter cover was torn in several places even though it had only been used a few times. (Fig. 2), Evidently, the framing tears through the material readily. It might be worthwhile to check the possibility of using a sturdy lightweight aluminum box for packing the framing. This would give better protection to the framing, and also eliminate the time needed for unlacing and lacing the present cover.

It was difficult to open the leather belts on the arches even with anti-contact gloves due to the stiffness of the leather. Aligning the arch supports so that the pins could be inserted was a time consuming operation. Several of the purlin braces were bent, but when and how this bending occurred is not known. Despite these minor difficulties the frame was relatively easy to assemble and seems to be the most efficient part of the tent to erect. The men were able to fasten most of the tent frame joints with arctic mittens, and the assembly time for the frame was approximately 15 minutes.

Lacing the three liner sections to the frame and then lacing the sections together was a tedious process and took about 30 minutes when heat

\*Because the material was so stiff and creased, the men could not get the grommets in the roof to coincide with the vertical pins mounted on the arches.



Fig. 1: Excessive stiffness and creases in outer skin of cold soaked tent.



Fig. 2: Tears in tent frame packing cover.



*Fig. 3: Lacing ten. liner sections to frame.*



was not used, and a somewhat shorter time when the tent was erected with the help of the heater. (Fig. 3). A different method of fastening the liner sections to the frame and to each other might shorten the erection time considerably. One possibility would be to use circular metal spring clips to fasten the liner to the frame, i.e., to the ridge and eave purlins. This type of clip is currently used to fasten the two end liner sections to the arches. Heavy duty snaps might be used to fasten the liner sections together.

One of the times that the tent was erected, the two end liner sections were reversed.\* As a result, there were no laces on one side of the center section and two sets on the other side. Thus, one edge of the center section could not be fastened to the adjacent end section. Appropriate marking would probably eliminate this problem.

Anti-contact gloves were used to fasten the liner and outer skin to the ground purlin. This operation took a fairly long time and in the process, one of the tying tapes was torn off. Here again, perhaps the operation could be speeded up by the use of spring clips on the liner. The wooden toggles on the outer skin were fastened with anti-contact gloves, and in the process two toggles were torn off. This fastening operation would have been very slow and difficult with arctic mittens. (Fig. 4) If feasible, heavy duty snaps might be more efficient than the toggles for fastening the outer skin sections together.

When the tent was erected without the help of the heater, one of the guy lines was torn off during an attempt to get the grommets in the roof of the wrinkled and cold-soaked outer skin to fit over the vertical pins in the arch supports. Also, without the use of heat it took approximately 20 minutes to close the zippers on the end flaps of the outer skin.

The stakes (or anchors) which are used to anchor the tent to the ground were not observed. Can these stakes be successfully pounded into ice or frozen ground?

A series of tests were conducted to determine the heating characteristics of the tent. With the launcher, trailer and rocket in the tent, using the heater-generator, it took approximately 35 minutes to raise the temperature (in the tent) to 48°F. at the height of three feet and 105°F. at the height of five feet. In a second test the tent was empty, and within about 35 minutes the temperature was raised to 92°F. at three feet and 109°F. at five feet. When the tent was opened so that the equipment (launcher, trailer and rocket) could be pushed in, the latter temperatures dropped to 51°F. and 60°F., respectively. Within 36 minutes after the

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\* This reversal error also occurred when the tent was erected outside the Hangar.



Fig. 4: Fastening wooden toggles on outer skin of tent

tent was closed, it was 80°F. at the three-foot level, and 99°F. at five feet.\* It should be pointed out that due to difficulties with the fastening procedure not all of the tying tapes on the liner and outer skin had been tied to the ground purlin. Also, the tent was not anchored to the ground. If all the ties had been made and the tent was anchored securely, the temperature gradients within the tent would probably have been reduced.

Striking the tent without the aid of the heater took about 45 minutes. Unlacing the liner and unfastening the wooden toggles took up a large proportion of the striking time. The stiff outer skin could not be folded compactly, and as a result, the canvas covers in which the outer skin and liner are wrapped were too small.

Approximately 45 minutes to erect the (warmed) tent would appear to be a serious handicap for a weapon system requiring rapid mobility.

b. Heater-Generator\*\*

The heater-generator is used to heat the interior of the tent and to generate power for lights. The difficulties with this equipment from the human factors viewpoint were mostly minor in nature. A screwdriver was necessary to unlock and lock numerous quarter turn "dzus" fasteners on the heater case cover and on the control panel cover. Opening and closing these covers would probably be more efficient with quick disconnect wing-head type "dzus" fasteners. Most of the controls on the panel were operable with arctic mittens. However, when the knob used to control heat was manipulated, arctic mittens blocked the surrounding numerals from view.

It was impossible to remove or replace the fuses with arctic mittens. But, this could be done with anti-contact gloves; fuses are not likely to require frequent replacement. It was almost impossible to completely connect the fuel line to the heater with arctic mittens. Connecting the ducts to the heater, and connecting the duct sections was a difficult operation regardless of the handgear worn. The starting cord was wrapped around the motor flywheel with anti-contact gloves. This operation would have been very difficult with arctic mittens. The lifting handles on one side of the heater are accessible and can be grasped with the mittened hand. However, it was extremely difficult to raise the handles on the control panel side of the heater into lifting position with mittens. (Fig. 5)

The heater ducts consist of six sections which are each approximately 12 feet long. None of these ducts are collapsible, and as a result they

\* The temperatures indicated are thermometer readings and are only approximate.

\*\*The heater-generator observed has been slightly modified, but the modified version was not seen.



Fig. 5: Attempting to raise heater-generator lifting handles.

take up a considerable amount of space in the truck (Rocket Handling Platform). It is thought that designing these ducts so that they are collapsible would be worthwhile.

The torch which is used to warm the working parts of the heater so that it can be started, can be operated with the mittened hand. The torch handles can be grasped easily with mittens, and the two rotary controls and the air pump can be manipulated with this handgear. However, gloves were used to strike the match used to light the torch.

c. Lamp assembly

The lamp assembly was previously observed in the hangar during the May 1959 cold weather tests (1). At that time, the cable (for the lamp) became stiff and cracked in many places and was not used. The cable on the present lamp remained reasonably pliable and did not crack. No difficulties were observed with the lamp, and it appeared to light the interior of the tent adequately.

d. There are a few problems and incompatibilities with the rocket spinning mechanism from the human engineering viewpoint. Regardless of the handgear worn, connecting the universal joint to the rocket was a time consuming process. Since the spinning is performed at a time when speed is vital, this connection should be simplified. The cover of the cartridge housing can be opened and closed with mittens, and the propellant cartridge can be inserted into the housing with this handgear. But, gloves were necessary to start threading the shorting plug into the cartridge. The latter handgear was also used to connect the firing line to the shorting plug and to the impulse hand generator. Those connections could not have been made with arctic mittens, however, the generator can be triggered with the mittened hand.

e. Rocket handling platform

The rocket handling equipment is mounted on a long-bed 2 1/2-ton truck. Although there were some mechanical engineering difficulties with the rocket hoisting equipment, from the human factors viewpoint it is acceptable. Arctic mittens can be used to mount and dismount the rocket saddles to and from the bed of the truck. The pin was inserted into the boom extension (telescoping boom) with mittens. But, it took a few minutes to align the holes in the boom and the extension so that it could be inserted. Mittens were used to attach the guide ropes to the end of the boom, and to crank the boom winch. The rocket handling sling can also be handled with the mittened hand.

## 7. Summary

Observations were made on human factors and compatibility problems in relation to the QMC clothing worn by the crew and the equipment of the LITTLE JOHN Weapon System during cold weather tests. The adequacy of the clothing in terms of the protection it afforded the crew, and its compatibility with the equipment have been discussed. Where appropriate, human factors problems were considered in relation to operational efficiency of the equipment. Suggestions were made for design changes which are necessary to make the operation of the equipment more efficient.

## 8. Conclusions and recommendations

a. The QMC clothing kept the men sufficiently warm under the conditions of the test.

b. A time requirement of 45 minutes to erect the tent seems to be a serious shortcoming for a weapon system being designed for rapid mobility. If feasible, a more pliable material for the outer skin is desirable, and a more efficient method of fastening the liner sections to the frame and to each other is needed. Once erected, the tent holds heat adequately.

c. From the human factors viewpoint, the difficulties with the heater-generator were mostly minor.

d. The Rocket Handling Platform for the most part is compatible with the QMC equipped man.

## 9. References

1. McGinnis, J. M. & G. Rosinger. Human factors observations during winterization tests of the LITTLE JOHN Missile System. Research Study Report, PB-25, U. S. Army, QM R&E Command, Natick, Mass., June 1959.

2. Rosinger, G. Human factors observations during winterization tests of the Phase II LITTLE JOHN Weapon System and the XM-70E1 Rocket Launcher. Research Study Report, PB-33, U. S. Army, QM R&E Command, Natick, Mass., December 1959.